

Industry 4.0 - A New Futuristic Technological Revolution A Catalyst of Innovation & Entrepreneurship in Creation of Enterprises



Devesh Rath, Ipseeta Satpathy, B. C. M. Patnaik

Abstract: *Industrialization is the crucial arm of an economy which is a dream for every single country on the globe. The theoretical term Industry 4.0 or Smart Factory delineates a societal and basic man comprehension of computerized innovative (digitalization) patterns which further subdivides the accompanying arrangements into Mobile gadgets, Internet of Things (IoT) stages, Location discovery advances, Advanced human-machine interfaces, Authentication and extortion identification, 3D printing, Smart sensors, Big information investigation and propelled calculations, Multilevel client communication and client profiling, Augmented reality / wearables, Cloud registering, haze figuring, man-made consciousness, AI, mechanical autonomy computerization and so forth. This paper manages the investigation of various parts of Industry 4.0 with it's entomb connection with advancement and business cultivating towards big business manifestations and upgrade of worldwide economy through innovative intercessions.*

Index Terms: Industry 4.0, Smart Factory, I4, Industrialization, Entrepreneurship, Innovation, IoT, Big Data, Machine Learning, Cyber Physical Systems, Automation, Robots, Artificial Intelligence, Augmented Reality, Wearables, Digitalization.

I. INTRODUCTION

Industrialization in its first period started its adventure with steam and the primary machines which automated certain works sought after by our progenitors. In this manner the utilization of power, the sequential construction systems and the introduction of large scale manufacturing appeared in second time. So also, the development of PCs with the start of mechanization, robots and machines supplanting work power on the sequential construction systems offered ascend to the third time of industry. Thus, presently in the new worldwide period of industrialization 4.0 PCs and mechanization will meet up in a through and through another way, with mechanical autonomy associated remotely to PC frameworks outfitted with AI calculations that can control the apply autonomy with least human help.

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Industry 4.0 has profoundly canny associated frameworks that make a completely advanced worth chain. It especially depends on digital physical creation frameworks that incorporate correspondences, IT, information and physical components and wherein these frameworks change the customary plants into savvy processing plants.

In the present universe of innovative work in the field of quick mechanical headways and industrialization "Industry 4.0 or Smart Factory" is all around heard comprehensively. This is named as the Fourth Industrial Revolution which takes into account current mechanization and information trade pattern in assembling advances in various circles. These are ordered into four fundamental classifications like digital physical frameworks, the Internet of things (IoT), distributed computing and psychological processing. In short the prime target is to empower machines converse with different machines and items alongside data which is handled and appropriated progressively bringing about significant changes to the whole modern biological system.

II. OBJECTIVES OF THE STUDY

- To examine the different components of Industry 4.0 and its impacts on varied industrial sectors.
- To study the role and impact of industry 4.0 in fostering innovation and entrepreneurship in creation of enterprises through modification of education systems.

III. INDUSTRY 4.0 OR SMART FACTORY / PRODUCTION LINE

The activity to build efficiency through digitization of the assembling area the Industry 4.0 upheaval was instated by the German Government in 2006. The German government in 2011 changed and abbreviated the expression "Business 4.0", to I4.0 or just I4 from a cutting edge technique venture of computerization and robotization of assembling at Hannover Fair through a working gathering known as establishing fathers and main impetus behind Industry 4.0 to be specific Siegfried Dais (Robert Bosch GmbH) and Henning Kagermann (German Academy of Science and Engineering). The enhancement of keen, adaptable supply chains, industrial facilities and dissemination models so as to catch and pass on more information to machines through machine-to-machine interchanges and to human administrators is the sole maxim of industry 4.0.



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This consequently empowers organizations for speedier, more brilliant choices, along these lines limiting expenses. The lifestyles of mechanical organizations alongside their representatives are changing step by step by three key patterns like Digitization, Industrialization and Optimization.

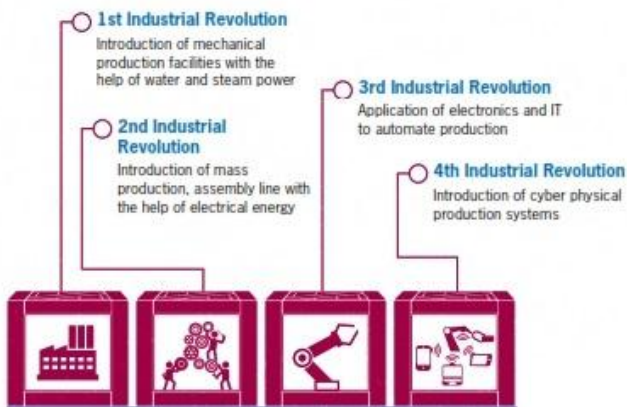


Fig-1. Industrialization road map

Industry 4.0 is guided by four general standards which bolster the method of recognizing and executing Industry 4.0 circumstances by organizations.

Interconnection: The limit of machines, contraptions, sensors, and people to interface and talk with each other by methods for the Internet of Things (IoT) or the Internet of People (IoP).

Data straightforwardness: The straightforwardness overseen by Industry 4.0 advancement outfits managers with massive proportions of profitable information expected to choose appropriate decisions by empowering accumulate enormous proportions of data and information between systems.

Specialized help: First, the limit of assistance structures to help individuals by totaling and envisioning information altogether for choosing instructed decisions and handling squeezing issues without earlier cautioning. Second, the limit of computerized physical systems to physically reinforce individuals by coordinating an extent of endeavors that is unpalatable, too much crippling, or unsafe for their human partners.

Decentralized choices: The limit of digital physical frameworks to choose decisions isolated and to play out their assignments as self-governing as could be normal considering the present situation. Just by virtue of extraordinary cases, impedances, or conflicting targets, are errands allotted to a progressively raised sum.

IV. COMPONENTS

Worldwide appropriation and agreeable endeavors prompts powerful usage of Industry 4.0 in this manner satisfying its vision and mission. The savvy production line idea has nine key specialized parts which are as follows.

Big data: Quantum being one of the significant difficulties with information. An intemperate measure of data makes it difficult to perceive the huge information and examples that can incite clever investigation. This is the place "Huge information" and examination becomes possibly the most important factor. They cause it possible to separate the show of an individual section and its working impediments in order

to stay away from future age issues and make protect move.

Cloud/ Distributed computing: The business has seen a gigantic move in utilizing cloud plans/arrangements, and this will continue creating. The cloud is being used for applications, for instance, remote organizations, shading the board, and execution/execution benchmarking and its activity in various business zones will continue developing. With steady types of progress in development, machine data and value will simply continue moving towards cloud game plans/arrangements.

Internet of things (IoT): The IoT is a key convenience in Industry 4.0 driven game plans/arrangements. IoT is a game plan of interrelated processing gadgets, mechanical and advanced machines, items and people that are given exceptional identifiers and the ability to move data over a framework without anticipating that human-should human or human-to-PC coordinated effort.

Simulations: The recreations of structures license evaluation of various circumstances when overviewed by, monetarily sharp courses of action attempted and completed significantly snappier provoking reduced cost and time to promote.

Autonomous robots: They are used to mechanize creation procedures over the various sections and are constrained by the possibility of Internet of Things (IoT). This interfaces devices and PC machines to talk with each other. Materials can be transported over the modern office floor by methods for self-sufficient portable robots (AMRs), keeping up a vital separation from obstacles, sorting out with naval force mates, and perceiving where pickups and drop offs are required continuously. By partner with a central server or database, the exercises of robots can be created and robotized to a more significant degree than whenever in ongoing memory. They can complete endeavors keenly, with unimportant human data.

Augmented reality (AR)/ Wearables: AR moves toward becoming being utilized by giving consistent information in a suitable manner to empower individuals to all the more probable consolidate and interface with electronic structures. Models can join the transmission of information on fixes for a segment that can be seen through different devices or the readiness of staff using generations and 3D points of view of the office or hardware.

Cyber surveillance: The surveillance of information winds up crucial as we move a long way from shut systems towards extended accessibility from the IoT and cloud. Security and constancy enable the successful use of a truly present day and digitized creation work process, using most of the upsides of a related circumstance.

System Integration: For the most part frameworks are exceptionally mechanized inside their very own tasks and battle to speak with different frameworks. Guidelines and open engineering bolster the simple exchange of data both to the business and to the client/end client.

Additive manufacturing:

This continues winding up dynamically critical for little pack applications or for the formation of individual parts or modified things. This will be used either honestly with the customer or by suppliers to improve plans with extended execution, flexibility, and cost suitability. 3D printing is one of the normal instances of such.

V. IMPACT OF DIGITALIZATION IN INDUSTRY 4.0

Anatoli Alop et al (2019) have described some questions on future education maritime professionals which encompasses the lifetime need for formal, informal, physical and digital education for future generations in an unpredictable future. The importance of digital transformation impact on enterprises efficiency and planning of effective business models has been discussed by Clemens Drieschner et al (2019). The idea of Digital Twin (DT) being a promising innovation empowering agent for savvy assembling and Industry 4.0 has been identified by Fei Tao et al (2019). Besides, DTs has been consistent integrators connect among digital and physical spaces and it has been effectively executed in different enterprises like item structure, generation, prognostics and wellbeing the board. Christof Ebert et al (2018) have portrayed a procedure of receiving problematic advances for expanding profitability, esteem creation and social welfare named as Digital Transformation (DX). DX is an innovation driven constant change procedure of organizations inside a general public. It's an unavoidable inserted figuring, network, and adaptable worth streams. Natalia Pantelieieva et al (2018) explained the need of Industry 4.0 in nation's advancement also the effect of digitization of economy through FinTech adventures. A trans-disciplinary and dispersed reflection based process is the word Digital Transformation (DT) as described by Rafal Maciag (2018). A dynamic space unification of reflection is Discursive space (DS) which is based on social constructivism a techno philosophical knowledge science. The resultant emergence in the space of discourses adventitious on space facts is DT.

VI. IMPACT OF COMPUTING IN INDUSTRY 4.0

Mithun Mukherjee et al (2018) have explained about a comparison between Cloud Computing and Fog Computing a new age advanced computation tool which extends faster communication, better storage facilities and delay sensitive service of a network. The fog computing architecture description is better efficient as a resource utilize in performance and better optimization in energy consumption bandwidth, delay management, critical issues, latency solver etc. Zude Zhou et al (2018) have clarified the effect of PC numerical control (CNC) machine device in Industry 4.0. It's an insight assembling apparatus which improves its activity self-sufficiency and joint effort ability through the digital physical frameworks by means of haze registering.

VII. IMPACT OF FIFTH GENERATION (5G) TECHNOLOGY IN INDUSTRY 4.0

Godfrey Anuga Akpakwu et al (2017) have corresponded the entomb reliance between Internet of Things (IoT) and 5G

arrange towards viable vision of Industry 4.0 being a promising innovation through heterogeneous brilliant gadgets empowering consistent availability enthusiasm for machine-type correspondences (MTC) through bleeding edge IoT vision. Maria A Lema et al (2017) have characterized the most appropriate 5G use cases that require ultra-low inactivity from both particular and business perspectives clarifying the needful worth of increment openings and worth option of 5G benefits in industrialization.

VIII. IMPACT OF ARTIFICIAL INTELLIGENCE (AI), AUGMENTED REALITY (AR)/ WEARABLES, SENSORS AND ADDITIVE MANUFACTURING IN INDUSTRY 4.0

Ongoing rapid usage in the field of intelligent Sensor networks to sense, calibrate the human motions, captured data through different activities to perform set objectives in daily life as well as industries has been studied by Yang Liu et al (2017). The impact of Artificial Intelligence in strategizing logistics digitalization, planning and performance monitoring management has been enumerated by Kurniawan et al (2018). Rachid Lamrani et al (2015) have explained the concept of pervasive computing a hassle free, seamless technology easing out lives of people via the concept of VR and AR with its application in various sectors like conceptualizing and development of different games, edutainment, knowledge etc as a part of progressive learning has been specified by the authors. Xudong Pan et al (2016) have presented the idea of virtual, increased and recreation based instructing and learning strategies in designing training consequently affecting a superior pragmatic encounter to understudies on various gear and consequently bolster the vision Made in China 2025 through developments and business. The concept and technology impact of Handheld 3D scanning AR a customized need based manipulative user friendly gesture capture technique and its application catering to industrial need has been explained by E G Su Goh et al (2019). Andreas Jakl et al (2018) have described the architectural user experience of AR by new methodologies, data transmission ease, certifications and industrial applications of the in I4. The increase in user growth of concept of Wearable Internet of Things (WIoT) devices which is emerging as a fast technological evolution engaging different industries and enterprises in monitoring and regulating healthcare, sports and daily living sectors has been delineated by Fangmin Sun et al (2019). Min Chen et al (2017) illustrated the gen-X worldwide requests on second era wearable items uniquely in the social insurance framework to improve the inside and out observing and security of people via distributed computing, big data, AI and various sensors and so forth as its physiological elements. Gang Xiong et al (2018) have followed out the idea of Social Manufacturing (SM) a novel idea which understands the client's needs and convert it to items as a general rule in this manner making its very own market. This incorporates the mediation of added substance fabricating, 3D printing, enormous information, IoT, astute frameworks, digitization, wearable's and so forth as a piece of Industry 4.0.

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IX. IMPACT OF BLOCKCHAIN, CYBER PHYSICAL SYSTEMS (CPS), CYBER ETHICS, AUTONOMOUS ROBOTS IN INDUSTRY 4.0

Md. Abdur Rahman et al (2018) portrayed the Blockchain based Mobile edge Computing (MEC) structure idea referencing its points of interest and advantages in medicinal services, restorative, military and so forth for the innovative society in different fields. The interrelation of blockchain based protocol with Industry 4.0 in economizing effective communication channels through autonomous bots, ROS (Robotic Operating Systems), gadgets, wearable's, drones etc have been delineated by the authors Aleksandr Kapitonov et al (2018). George Hurlburt (2018) described about the ethical cyber practices in Industry 4.0 by protecting interest of each individuals and industries. Paulo Leitao et al (2016) laid out the idea of Cyber Physical Systems (CPS) in cutting edge modern frameworks including man-made brainpower, IoT, Machine Learning to accomplish multifaceted nature the board, decentralization, information, segregation, flexibility, energy, alteration, besides, responsiveness as a piece of mechanical development. Anatolijs Zabasta et al (2018), Elena Mäkiö-Marusik (2017) set apart out the nitty gritty innovative progressions in the field of CPS and the requirement for legitimate specialized courses configuration obliging the learning and substance production of CPS among the understudies in the colleges. Shunmugham R. Pandian (2018) has enumerated the edutech method of learning in schools and colleges via autonomous robots thereby giving a real time practical knowledge and scientific know how to students by enhancing better learning prospects among them. Sami Haddadin et al (2018) have explained the need for technological advancements through AR and autonomous robots for rapid industrialization I4 in various fields. Florian Maurer, Jens Schumacher (2018) have outlined the concept of Factory of Future (FoF) based on a European Union study which caters to Industry 4.0 industrial overall management fostering innovation, entrepreneurship through CPS and digitization.

X. IMPACT OF INTERNET OF THINGS (IoT), BIG DATA AND DEEP LEARNING IN INDUSTRY 4.0

Jian-Qiang Li et al (2017) portrayed the effect of IoT through its design structure, usage, oppositions and its utility in genuine world among populace. The idea of Human feelings acknowledgment a techno clever progression in the field of IoT through systems of face compromise, passionate trades has been delineated by Wentao Hua et al (2019). Pawani Porambage et al (2018) depicted the idea of multi-get to edge registering (MEC) innovation the fifth era remote correspondence system relying on the 5G innovation which includes a viable commitment to Smart Factory idea. Yong Tao et al (2018) marked out the concept of intelligent manufacturing by China called as Internet Plus which involves network cognition, industrial cloud computing, automation etc as a part of I4. Halimah Badioze Zaman et al (2017) have sketched out the reasonable structure of Smart Neighborhood which includes interfacing of enormous information, profound learning, distributed computing, digitalization of economy adding to I4 consolidating in

various components of modern application. The different monetary parameters of I4 tending to upgrade of worldwide market has been identified by the creators Blesson Varghese et al (2018).

XI. IMPACT OF EDUCATION AND ENTREPRENEURSHIP IN INDUSTRY 4.0

Qinglong Zhan, Mengjia Yang (2017) have explained the need for Smart Technologies enabled education involving innovation and entrepreneurship in China for better learning as an economy add on. Claudio Demartini et al (2017) has outlined the importance of architectural model of web 4.0 along with Industry 4.0 in catering tremendous education potential knowledge management among students. Ricardo A Ramirez-Mendoza et al (2018), A.V. Andryushin et al (2018) have detailed the need for knowledge management of industrial automation, industry 4.0, CPS, entrepreneurship, innovation, latest ICT trends for engineering technocrats as a part of course curriculum to deal with future needs in different parts of the world being industry ready for I4. There is a vital character for Computer Aided Technology studies, Programmable Technologies for building future educational institutions youths I4 as marked out by Mehmet Aksit (2018). Varghese Panthaloorkaran (2019), Dario Assante et al (2019) have delineated the need for Smart Education system featuring all the parameters of Smart Factory as a part of course curriculum in different university and school level to foster innovation and entrepreneurship driven society in support of rapid industrialization. Qin Jun, Xiao Jing (2017), D. Cetindamar, et al (2018) traced out the birth of entrepreneurial ecosystems from digital technologies development within city based enterprises which caters to I4 thereby enhancing different development prospective within them. The method of Interactive, Collaborative Learning technique leads through open innovation which in return generates diversity in new generation students towards technological interventions as outlined by Jhonattan Miranda et al (2017). The lean manufacturing concepts introduction through digitization, efficient performance and managerial strategies being a pivotal arm of Industry 4.0 has been narrated by Eva Rother, Armand Baboli (2019). Mousumi Roy, Abhijit Roy (2019) have narrated the need for disrupted technologies, smart management systems, digitization, parameters of I4 which becomes a prime mover in motivating youths towards innovation, entrepreneurship and enterprise creation. Dr. Yuriy V. Seniuk (2018) correlates innovation, entrepreneurship as an interlinking factor between university fostering entrepreneurship and industrialization fourth generation resulting in creation of enterprises globally. The education tricks and techniques on innovapreneurs (Innovation Entrepreneurs) in different parameter of Industry 4.0 can lead towards economic development.

XII. METHODOLOGIES

The study is predicated on the secondary information. During this regard numerous libraries visited and a few on-line journals were conjointly reviewed during this direction. The different applications of various components of Industry 4.0 were studied and the pivot role of each vertical through digital transformation in Industry 4.0 was interposed. The proposed Fig-2 represents the interrelationship between Industry 4.0 which comprises of various components for rapid industrialization like IoT, Big Data, Machine Learning, Cyber Physical Systems, Automation & Robots, Artificial Intelligence, Augmented Reality & Virtual Reality and Wearables and Digital Transformation, Additive Manufacturing being an enabler in different industrial sectors across the globe in fostering Innovation & Entrepreneurship thereby creating enterprises and employment generation.

XIII. RESULTS AND DISCUSSION

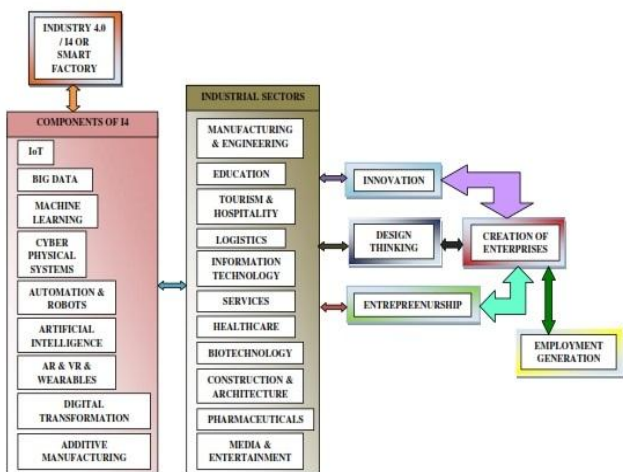


Fig-2. Structural representation of relationship between Industry 4.0, Components of I4, Industrial sectors, Innovation, Design Thinking, Entrepreneurship & Creation of Enterprises and Employment Generation

An elaborative analytical study was conducted based on the related works done on the impact of different components of industry 4.0 which resulted in the formulation of the structural representation of interrelationship between Industry 4.0, Components of I4, Industrial sectors, Innovation, Design Thinking, Entrepreneurship & Creation of Enterprises and Employment Generation as per mentioned in Fig-2 & Fig-3. It's been observed that the technological intervention in industrialization, specifically in the fourth generation industrialization owes a huge impact on the global economy and with the era of digital transformation, 5G, AI and AR & VR being a smartest mode which plays a pivotal role. In any case, as the world is preparing for the I4 transformation, our youth masses are yet to get talented with legitimate ranges of abilities to experience with the cutting edge innovative war. Furthermore, the duty of different educational institutions and universities for development of new age work force, innovators and entrepreneurs is of prime concern.

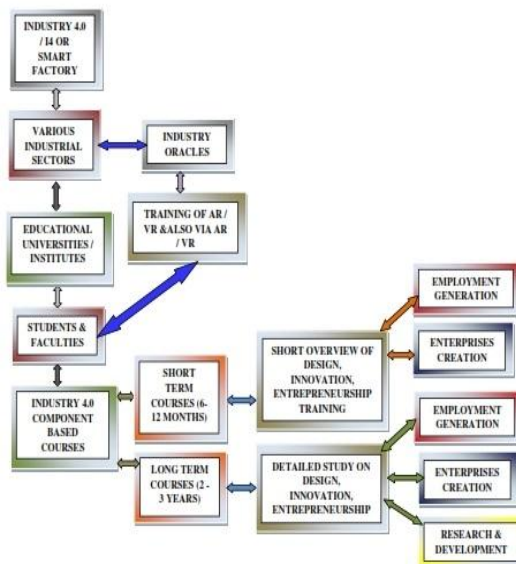


Fig-3. Structural representation of implementation advantages of courses and training to cater to needs of Industry 4.0

The Fig-3 speaks to the procedural execution and favorable circumstances of plan of various short term and long term courses alongside preparing in colleges level and organizations level taking into account the necessities of Industry 4.0. The fundamental difficulties for the business 4.0 is the promptly inaccessibility of gifted labor for plan, advancement and operational capacities of the accompanying needs. The needful cutting edge necessities for industrialization the instructive colleges/organizations are should have been exuberated with age of techno sharp experts to alter with the business 4.0 prerequisites through the mediation of digitalization channel medium. Consequently, the understudies and resources' club are to be prepared with the most recent systems through the business specialists' conference in this manner detailing transient courses going on for 6-12 months and long term courses of 2 to 3 years through qualification or ace courses. What are more the various parts of configuration thinking, advancement learning and business enterprise the executives are wanted for driving open doors in endeavors creation and work age. In view of the examinations it's in addition seen that in the worldwide training situation a portion of the colleges have begun the present moment and long haul proficient degree courses in AI, Machine Learning, Additive Manufacturing, AR and VR and so on, yet starting at now in India we are yet to actualize a total proficient investigations empowered gifted seminars on different needful necessities taking into account Industry 4.0 basics in educational universities/institutions level. In contrary at present certain transient courses for fundamental bits of knowledge of the said innovations are accessible. In any case, to speed up the financial improvement and upgrade the possibilities of innovative work of the country India the accompanying courses should be actualized in a customary premise to walk with the worldwide benchmarks satisfying

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the country's advanced requests and moreover cultivating a dynamic culture development/innovations and business enterprise/entrepreneurship by making of multifold undertakings in not so distant future.

XIV. RATIONALITY OF STUDY

All though the following paper is a conceptual theoretical paper, but the study along with its suggestions as mentioned by authors enumerates the procedural measures and possible importance of skill sets building in education sector right from grassroots level. The introduction of various modules of components of Industry 4.0 in different phases of education career of an individual like school education, undergraduate, graduate, post graduate, doctoral studies and post doctoral studies with varied prospects of competencies can develop a techno enabled society with better qualitative workforce creation along with creating a spark and excitement on innovation and entrepreneurship thereby creating new enterprises among youth in a verge of developing problem solving attitudes for different odds and oddities encountered by societal living beings. The study in addition enables a wide range of research and development prospects among varied cross functional spheres thereby adding to new product development along with overall economic development of the nation.

XV. SCOPE OF FUTURE STUDY

This conceptual theoretical study paper encompasses the scope of detailed empirical study among various youths and start up enterprises to acquire and analyze data about their knowledge on Industry 4.0 and in addition the practical needful application of different components of I4 being incorporated amidst them. This moreover helps in evaluating the future prospects of R&D, policy making, distinctive law making prospects for nation's fiscal augmentation.

XVI. CONCLUSION

Thus this detailed study infers that the rapid vision of global industrialization through continuous process of research and development by various countries, industries towards innovation and seamless performance of the business is in a big run. Different nature's prospective vision 2025 is to incorporate the highest optimum industry standards known as Industry 4.0 or I4 or Smart Factory concept thereby becoming an economy leader. Digitization Transformation through the IoT, ICT, Additive Manufacturing, 3D Printing, Intelligent Manufacturing, Augmented & Virtual Reality, Wearables, Sensors & Actuators, Cyber Physical Systems (CPS), Cyberethics, Autonomous Robots, UAVs, Big Data, Machine Learning, Deep Learning, AI etc has emerged to be a technological ruler globally with human race being completely dependent in easing out of process and optimization of avenues and resources. So, in context to the global youth fraternity there is a need for knowledge management and technological up-gradation through learning, skill-sets development, continuous R&D, innovation and entrepreneurship fostering through education modules from school and universities level. The resultant of

the same will lead towards different enterprises creations deciphering different industrial needs in Industry 4.0 towards thriving of the global economy. Thus, Industry 4.0 is the futuristic growth and development of the globe which needs each and every nation's cooperation to achieve the vision collectively and collaboratively across all sectors of industrialization.

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